



COMPLEX OF FACILITIES AND METHOD OF ICEBERG INSULATION WITH FURTHER PRODUCTION OF FRESH WATER

Background of the invention

The present invention relates to the field of non-traditional sources of fresh water, and, namely, to icebergs application as such a source.

At present a number of inventions on the subject are being known. All of them are based on iceberg towing from the poles to the port of destination.

The main problem to be solved in this case consists in minimizing the iceberg losses due to melting in warm waters and from destructive action of waves.

That's why all the developments patented up to now differ mainly in proposals on iceberg protection from mechanical action of waves as well as in different variants of its thermal insulation.

So, e.g. US patent 4289423, 1981, Int.Cl. E02B01/00 protects the following:

"A protective skirt for a tabular iceberg comprises a string of floating posts which support an upper protective portion near the water line. This portion is constituted by flexible panels which provide both thermal protection and mechanical protection against wave action. Certain posts include vertically arranged furling drums for winding-in the panels attached thereto in order to fit the length of the skirt around the perimeter of iceberg. The skirt also includes a lower protective portion which is suspended from below the floating posts. This portion need only provide thermal protection since it is suspended below the deepest expected wave troughs. It is too large (e.g. 200 m) in the vertical direction for it to be conveniently wound-in on furling drums like the upper protective portion. In order to accommodate changes in the perimeter of the upper portion it is therefore split vertically and adjacent spans allowed to overlap by a variable amount using an auxiliary float moored some way along the upper portion."

Great Britain patent GB 2018688, 1979, Int.Cl. E02B3/06 protects the following:

"A large scale floating device for providing protection against the mechanical effects of waves and swell, usable in particular with tabular icebergs, comprises rigid units with positive buoyancy connected together by elastic connecting units beneath which is located a thermal protective device. The connecting units comprise elastic belts designed to operate in tension and fastened together to form a net which provides substantial opposition to the passage of water therethrough – e.g. it may obstruct 50 % of the area over which it extends."

US patent 4258640, 1981, Int.Cl.E02B 15/04 protects the following:

"A large-scale protective device in accordance with the invention comprises an assembly of two types of unit, rigid cylindrical floating towers and elastic connecting units consisting of elastomer tubes. The generatrices of these elastic connecting units are in contact with vertical stiffeners of the floating towers. These vertical stiffeners also serve to maintain cylindrical deflector wings of the floating towers one above another in a stacked configuration.

German patent DE 3531435, 1987, Int.Cl. B65D88/78; B63B35/00 protects the following:

"A device for transporting icebergs in water, having a tube which receives the iceberg, has weights which stabilize its transporting position and reinforcing means, and can be closed at both its ends, the stabilizing weights being mounted along the longitudinal extent of the tube in such a way that its longitudinal axis runs in the direction of transport and the tube consists of at least two layers which between them form hollow spaces for the circulation of a coolant."

"Method of manufacturing a protective skirt for a tabular iceberg" (US patent 4172751, 1979, Int.Cl. E02B01/00) proposes the solution in some way similar to that mentioned in US patent 4289423: "Panels of cloth or sheet material are reeled out in parallel plane layers and joined in pairs along alternate edges to form a folded structure which can be deployed around at least a part of tabular iceberg and then allowed to extend concertina-fashion to provide a protective jacket next to the flanks of the iceberg. The upper part of the skirt can be of more robust material in order to stand up to the action of waves and swell, while the submerged portion (deployed concertina-fashion) serves to keep warm water from coming in contact with the iceberg. The skirt is intended to protect icebergs being towed from Antarctic seas to the tropics."

And, finally, the review of patented solutions can be completed by "Flexible covering for icebergs" (German patent DE 3315744, 1984, Int.Cl. B63B35/00: "The invention relates to a flexible covering for icebergs made of a waterproof cover film. The cover film is designed as

an immersible film web having a web length and width adequate for extending under the respective iceberg in a trough-like manner. At its longitudinal and lateral sides it has inflatable float tubes. At least one of the float tubes is subdivided into air chambers which can be inflated separately from one another. A cover film which can be pulled over the respective iceberg is fastened to one float tube, which cover film can be connected to the other float tubes or film sides in a waterproof manner."

Despite the variety of technical ideas on iceberg protection from waves and its thermal insulation against melting, all the solutions proposed have some common features which negatively influence the expected result and cause difficulties in attaining the goal set forth.

In particular, these features are as follows:

- All the solutions acknowledge only one method of fresh water delivery to the consumer, i.e. towing preliminary protected iceberg from the pole to the port of destination.
- All projects are destined for utilizing icebergs from one of the poles, and, namely, Antarctica.
- All projects in drawings and schemes represent iceberg in the form of a well-shaped bar drawn at geometrically right angles, as well as having even edges and surfaces.

Presence of even one of these features in any of the projects proposed would considerably decrease their chances, and their combination causes serious doubts in the possibility of realizing even one of them.

In reality, orienting only on icebergs of the South Pole (Antarctica) narrows the material base of developments for a half.

Concerning towing of preliminary protected and insulated iceberg, it can be said that with one-sided orientation of South pole icebergs towing should be done practically throughout the whole planet as all the industrially developed countries with the highest consumption of fresh water are situated exactly in the Northern hemisphere.

The route of such towing should inevitably cross the equator, and that fact only gives understanding of the volume of work on iceberg thermal insulation.

In relation to schemes and drawings where the iceberg is shown as a well-shaped bar, it can only show how far are these projects from the real situation.

In reality Southern pole icebergs sliding under pressure into the ocean along the Antarctica shelf acquire flat shape as the result of this motion.

But this reflects only relative flatness of their surface and bottom, contours of side parts can, in this case, acquire any fracture line.

But the main reason which made it impossible for any of the projects to be introduced into life is connected with the fact that it is

practically impossible to realize all the necessary volume of activities on iceberg protection against the destructive action of waves and to reliably insulate iceberg from melting in warm waters (even in the simplest of the projects).

It shouldn't be forgotten that the complex of activities mentioned in any of the projects submitted should be performed far from industrially developed and technically equipped ports and terminals, under severe conditions of polar seas.

Several practical attempts undertaken in the middle of the last century only certified this conclusion: all that remained from the towed iceberg after destructive action of waves, melted completely in the tropics.

The main aim of the proposed invention consists in utilizing fresh water of the melted iceberg avoiding drawbacks of the solutions analyzed earlier.

In the invention proposed it would be possible to use icebergs of the South as well as the North poles; towing would be carried out at considerably shorter distances, etc., but what is more important is that the solution proposed can, on the one hand, preserve all the fresh water volume of the iceberg treated, and, on the other hand, project realization can be carried out by modern industrially developed countries.

Summary of the invention

The goal set forth can be attained by placing the iceberg into a gigantic cover ("bag") made of waterproof material.

After that the iceberg packed into a bag continues its own drift and it begins to melt when entering warm waters, but in this case its fresh water remains inside the bag.

Thus, when iceberg melts completely, a gigantic "hot water bottle" full of fresh water will drift on the ocean surface.

Then, this gigantic "hot water bottle" can be towed to a port, pumping water into water tankers in open sea being also possible, etc.

The main scheme (real sequence of actions) of placing the iceberg into the bag is proposed to be as follows.

Taking into account huge iceberg sizes, the cover into which the iceberg must be placed doesn't look like a bag in the usual meaning of the word.

Initially it looks like a gigantic cloth made of waterproof material, mainly in the form of a circle (shapes of ellipse, rectangle, square, etc. are also permissible).

In case the cover is rolled up as a carpet, simultaneously from two opposite sides towards center, then two equal rolls rolled up to meet one another in the center and connected by a common flat strip are obtained.

Thus, the cloth is turned into a structure which is called a "doubled roll" in the patent proposed.

The doubled roll is turned with its flat strip up and is moved under the iceberg at its deepest point in the underwater part so that the ends of the doubled roll remain above the water surface on two opposite sides of the iceberg.

As the doubled roll is pressed against the underwater part of the iceberg by its flat strip, at a certain moment it can be possible to begin the reverse process of unrolling the rolls along the iceberg bottom into directions opposite to one another.

In the process of unrolling the flat strip connecting both rolls will become wider and wider embracing larger surface of the iceberg underwater part.

By rolling from each other in the opposite directions, the rolls attain opposite edges of the iceberg bottom, after which their unrolling will be continued along the lateral sides of the iceberg underwater part, i.e. in the upward direction to the water surface.

When the rolls will be finally unrolled and reach the water surface, the doubled roll will again become a cloth embracing all the

underwater part of the iceberg, and the ends of the cloth surround the upper part of the iceberg as a ring on the water surface.

After lifting the cloth edges over the upper part of the iceberg and covering the iceberg peak, the iceberg appears to be inside a waterproof cover, i.e. submerged into a bag.

The summary of the invention (as a complex of means) is to be explained below in more detail.

Cloth of a considerable length serves as the main and basic material parts of the technical solution proposed. It is manufactured in the same way as packing material called "bubble". ("Bubble" represents a packaging roll material having the cloth made of small air cushions welded together).

According to this approach the cloth consists of two layers of waterproof material. Watertight connection of these layers is attained by adhesion or welding along the preliminarily marked lines. By connecting straight vertical and horizontal lines a net which covers all the cloth is formed. Each cell of this net represents an enlarged copy of the air "bubble", as it is also made as a hollow rectangle or square where the two layers serve as the basic surfaces and connecting lines represent faces on all the four sides, i.e. according to the shape and the essence it is considered as an air cushion.

A group of thin flexible air ducts is run in between the connecting layers. Each air cushion has an end of such an air duct introduced inside, while opposite ends of all the ducts meet together at the edge of the cloth forming a compact knot.

This small area at the edge of the cloth where all the ducts meet is called "outlet" in the given invention.

The "outlet" is the area in the cloth which serves as a communication unit between the cloth and the technological vessel. In design this communication is represented by a braid consisting of a towing rope and air ducts equal in number to those existing in the cloth.

Cloth connection with a technological vessel is called a "navel-string" in the given invention.

When connected with the "outlet", air ducts in the "navel-string" are connected with air ducts of the cloth serving as their continuation up to air pumps of a technological vessel.

Thus, the navel-string may serve as the place of pumping or sucking the air in and out of the air cushions in the cloth, thus providing for their floating up or submerging.

Air cushions in the cloth cover it in longitudinal and transverse rows representing cells in the connection net (adhesion).

Position of the "outlet" center is determined as the point of crossing of the cloth edge with its diameter taken parallel to one of the air cushion rows (irrespectively longitudinal or transverse ones).

The central row of air cushions going along the cloth diameter and terminated by its outlet at the end is considered to be the middle of the cloth in direction of which the cloth is rolled from the opposite ends to form a doubled roll.

In the present patent the term "rows of air cushions" means only the rows of air cushions parallel to the cloth middle in direction of which rolls are rolled up.

Thus, the rolls rolled from the material edge towards the middle will wind up on themselves the rows of air cushions as their longitudinal components.

The doubled roll is formed when two rolls meet in the middle of the cloth, i.e. the elongated structure consisting of two rolls with only a flat strip connecting them remains.

Several rolls of air cushions go along all the strip, the central one at one of the doubled roll ends is terminated by an outlet.

"Navel-string" is connected to the "outlet", and after pumping the air in for roll buoyancy on the water surface, the doubled roll is transformed into a floating structure where rolls themselves play the role of sides, flat strip between them plays the role of a bottom, and "navel-string" is the towing bond with the technological vessel.

After the doubled roll has been formed, it is towed to the iceberg.

When approaching the iceberg, a winch is being loaded on it. The winch cable is secured to the rear end of the doubled roll, i.e. to that end of the roll which serves as its stern.

Then the air is pumped out of the doubled roll, and it goes down into the water in the position close to a vertical one, with only its front end connected by a "navel-string" to the technological vessel remaining above the water.

This having been done, the technological vessel begins its movement round the iceberg and, having finished a semi-circle stops on the opposite side.

During this maneuver the rear end of the doubled roll to which the cable has been secured before submerging has made the same semi-circle round the iceberg but at depth.

At the new stop the cable secured to the rear or, according to its new position, a lower end of the doubled roll, sags under the iceberg and appears on the surface at the former stop, i.e. on the side opposite to the new ship stop.

After this the winch begins to wind up the cable which, in its turn, lifts the lower end of the doubled roll.

During lifting the doubled roll approaches the underwater part of the iceberg and, having touched it, begins to get pressed to it moving consequently along its contour first deeper and then along the bottom of the iceberg, and at the final stage – upwards to the water surface.

At the end of this lifting, the end of the doubled roll would be taken by the cable to the water surface at the side of the iceberg opposite to the technological vessel stop.

Thus, the doubled roll moves under the iceberg embracing its underwater part from one side to another.

Preliminary operations providing for correct position of the doubled roll under the iceberg are to be carried out before this process, and, namely, turning the roll with its flat strip upwards when compared to its position during towing.

The process opposite to doubled roll formation, i.e. unrolling of the rolls in opposite directions along the underwater part of the iceberg, is possible only under this condition.

In its correct position, the doubled roll is pressed to the underwater part of the iceberg by its flat strip, with two rolls positioned on both sides of it.

Two narrow strips are also positioned along this flat strip on both sides of it and occupy intermediate position between the flat strip and the line on the top of each roll from which it begins to slope down.

Thus, each of these intermediate strips, being pressed by one of its edges to the bottom of the iceberg, then withdraws from it and passes into the rolls at increasing angle.

These two strips are named in the present invention as “intermediate parts”.

Rows of air cushions move along the flat strip as well as these intermediate parts along all the length of the doubled roll under the underwater part of the iceberg.

In case air is pumped into the rows of air cushions of the flat strip, then it, by trying to float up, will only be pressed closer to the bottom of the iceberg but its width will remain the same.

In case air is pumped into air cushions of two intermediate parts on both sides of the flat strip, then they, by trying to float up, will make clearance between them and the iceberg wider and only after this operation will be pressed against the iceberg.

But as the result of this the flat strip pressed to the bottom of the iceberg will widen in both directions for the width of these two intermediate parts, thus moving the rolls apart.

After this, the air is pumped again and again into the intermediate parts which will appear between the widening flat strip and the rolls moving further from one another and decreasing in diameter.

During this process the widening strip will embrace all the bottom of the iceberg coming to its edges, and rolls continue to be unwound along the sides of the iceberg in the direction of the water surface.

Having reached the surface, the rolls will make a special "ring" of a certain diameter surrounding the upper part of the iceberg like an island.

This means that the doubled roll has again become a cloth with its main part embracing the underwater part of the iceberg and the remaining part floating on the surface.

"Navel-string" which is not necessary at that moment is removed from the cloth and loaded on the technological vessel.

After this, by means of the winch which has been delivered to the iceberg at the beginning of the operation the part of the cloth floating on the surface is raised on the upper part of the iceberg and closes it.

Personnel which was performing all the operations transfers all the equipment existing on the iceberg to the technological vessel, and then the iceberg packed into this cover ("bag") continues its natural drift.

By entering the warm waters it will melt but that time its fresh water will remain inside the capacity ("hot water bottle").

Then drifting capacity can meet a water tanker which will pump the fresh water from the capacity into the tanker and deliver it to the port of destination.

In another variant towing of the capacity into the port of destination can be carried out with further pumping the fresh water out.

Brief description of the drawings

The essence of the invention can be explained by the drawings attached herewith where it is shown:

- Fig. 1 – general view of the cloth of considerable length,
- Fig. 2 – Component parts and details inside the cloth between connected layers,
- Fig. 3 – A layer of the cloth forming the outer surface of the cover (“bag”),
- Fig. 4 – A layer of the cloth forming the inner surface of the cover (“bag”),
- Fig. 5 – A cloth rolled into a doubled roll in the position for transportation,
- Fig. 6 – Illustration for cloth edge preparation for rolling it into a doubled roll,
- Fig. 7 – Illustration for beginning the process of cloth rolling onto a doubled roll.
- Fig. 8 – Illustration for continuing the process of cloth rolling into a doubled roll,
- Fig. 9 – Scheme of air delivery into the roll for its continuous rotation,
- Fig. 10 – A doubled roll on the ocean (sea) surface with a flat strip turned up in comparison to its transportation position,
- Fig. 11 – Position of an iceberg and a doubled roll before roll submerging,
- Fig. 12 – Position of a doubled roll at the beginning of submerging,
- Fig. 13 – Position of a submerged doubled roll before its towing to the opposite side of an iceberg,
- Fig. 14 – Position of a submerged doubled roll after its towing to the opposite side of an iceberg,
- Fig. 15 – Position of a doubled roll at the initial stage of girding the underwater part of an iceberg,
- Fig. 16 – Position of a doubled roll when finishing girding of the underwater part of an iceberg,
- Fig. 17 – Top view on the iceberg after girding its underwater part by the doubled roll,
- Fig. 18 – Cross-section of the iceberg bottom with the roll pressed against it by its flat strip,
- Fig. 19 – Illustration of the process of flat strip widening along the underwater part of an iceberg,

- Fig.20 – Top view on the iceberg in the process of flat strip widening along its underwater part and on the water surface,
- Fig.21 – Top view on the iceberg after finishing complete girding of its underwater part by the cloth and floating up to the surface of the outer edges of the cloth,
- Fig.22 - Position of the iceberg with all its underwater part girded by the cloth,
- Fig.23 – Position of the iceberg with all its underwater part girded by the cloth after pumping out sea water,
- Fig.24 – Upper part of the iceberg before it being closed,
- Fig.25 – Upper part of the iceberg after its closing,
- Fig.26 – Parts of bracing belts on the water surface,
- Fig.27 – Towing of a capacity (with fresh water) which has an elongated form for decreasing water resistance.

Description of the preferred embodiment

The proposed invention in the embodiment chosen can be effectuated in the following way.

As it has been shown in the division "Summary of the invention" a cloth of considerable length mainly in the shape of a circle (shape of an ellipse, a rectangle or a square, etc. being permissible) serves as the basis of the whole technical solution.

It consists of two layers connected together by adhesion or welding and its general view is presented in Fig.1, while component parts and details positioned between the layers are given in Fig.2 (a cloth fragment).

Connection lines 1 (Fig.1,2) cover all the cloth in the shape of a net with separate cells in the form of squares or rectangles representing air cushions 2 (Fig.1,2).

Connection lines are laid in such a way that each air cushion is separated from the neighboring one at all the four sides by narrow passage or channel 3 (Fig.1,2).

Thin plastic tube – air duct 4 – is introduced into each air cushion (Fig.1,2).

All air ducts 4 from the air cushions go along channels 4 and make one compact knot at the cloth edge which is called in the present invention as "outlet" 5 (Fig.1,2).

"Outlet" is positioned at the intersection of the cloth edge with its diameter which passes parallel to any rows of air cushions (unimportant whether longitudinal or transversal).

In the present invention the term "row" or "rows of air cushions" means a row or rows of air cushions only belonging to this direction 6 (Fig.1).

Connection of cloth layers together also occurs by means of spot connections 7 (Fig.1,2).

Spot connections are uniformly positioned on the air cushion surface and are destined for air cushions preservation of as flat a surface as possible as their main function is to serve as the iceberg cover.

Besides spot connections and net lines the layers are joined together along the circumference.

Such connection is carried out along the outer edge of the cloth 8 (Fig.1) where lifting loops 9 are positioned at equal intervals.

At the final stage when the iceberg will be enclosed by a bag, one the cloth sides will become the outer side of this bag which is called a "bag-bubble" in the present invention, and another will become an inner one.

In Fig.1 the cloth is shown with that layer up which will become the outer side of the "bag-bubble".

The drawing shows the system of bracing belts 10.

They are better shown in Fig.3 where this layer of the cloth is presented.

Bracing belts represent two groups of concentric rings.

Each of these rings represents a belt which is passed through corresponding loops positioned uniformly along the ring circumference so that each of the rings can be tightened or slackened.

When the iceberg will be enclosed by the bag-bubble", then the rings of bracing belts embracing any volumetric shape will be similar to parallels on the globe but positioned vertically and not horizontally.

After that tightening of the belts having rings on the upper part of the iceberg takes place resulting in close pressing of the "bag-bubble" to the iceberg, thus preventing "bag-bubble" from impacts of waves.

Another side of the cloth (which cannot be seen in Fig.1) will act as the inner side of the "bag-bubble".

At the final stage when the iceberg would be enclosed by a "bag-bubble", not only the iceberg but a considerable quantity of sea water would appear inside it.

To remove this water the side of the cloth which is to become the inner layer of the "bag-bubble" (Fig.4) is fitted with several orifices 11.

These orifices serve as the beginnings of flexible plastic pipes 12 (Fig.2) which, similar to air ducts 4, are laid in channels 3 between the air cushions and terminate in "outlet" 5 (Fig.1,2).

Position of orifices 11 (Fig.4) should be such as with further connection of layers they are to appear between air cushions, i.e. in the channel 3 bed or at their intersections.

As it has been shown above, design differences between the layers out of which the cloth is connected (adhered) depend on the fact which role will this or that layer play in the "bag-bubble": whether it will be an outer or an inner layer.

Along with it, both layers have common features.

Geometrically, i.e. in sizes and edges configuration they should be absolutely identical.

As for their physical and mechanical properties, both layers should possess such qualities as water impermeability, strength, small specific weight, flexibility and elasticity as well as not to be subjected to influence of sea water, sun, wind and high temperature difference.

For its further application the ready cloth should be delivered to the iceberg.

To attain this, the cloth should be rolled into the shape most suitable for towing.

The cloth rolled into such a shape is called a doubled roll in the present invention (Fig.5).

For transforming the cloth into such a shape, the cloth in the spread state (Fig.1) with the layer with bracing belts up is rolled simultaneously from both opposite sides towards the middle.

Diameter on intersection of which with the cloth edge there exists "outlet" 5 is considered to be the middle in the given case.

Thus, at the end of rolled the cloth from initially flat one is transformed into an elongated construction consisting of two rolls 13 (Fig.5) rolled one to meet another and connected to one another by flat strip 14.

This flat strip represents this very middle of the cloth where both rolls meet.

At one of the butt ends of the flat strip and exactly in its middle there exists "outlet" 5.

In such a shape the doubled roll can be towed along the water surface as a floating means where the rolls serve as sides and a flat strip connecting them plays the role of a bottom.

To realize this process a connecting link between the roll and the technological vessel towing it should be necessary.

Such a connecting link in the present invention is called a "navel-string".

A "navel-string" represents a flexible elongated construction consisting of air ducts and pipes packed together and corresponding

in their number to those which exist in the cloth as well as the towing cable.

The "navel-string" is connected by one of its ends to the doubled roll in the point of the "outlet" while with the other one it is connected to the corresponding equipment on the stern of the vessel.

When towing the doubled roll the towing cable in the "navel-string" bears the main load.

The towing cable is connected by one end to the hook on the stern and with the other – to the corresponding attachment at the doubled roll "outlet".

Air ducts and pipes in the "navel-string" are connected with their analogues at the doubled roll "outlet", and with their opposite ends they are connected correspondingly to air and water pumps of the vessel.

Thus, pumping air in or out of the cloth can be carried out through the "navel-string" into the air cushions of the cloth, doubled roll or "bag-bubble", as well as pumping out water from them.

Pumping air in and out of the air cushions can be carried out according to a complex program, e.g. in a definite sequence along separate rows of air cushions, or with simultaneous pumping in and out in different rows of air cushions, or even per separate air cushions.

Due to this fact, the process of "pumping in and out" should be controlled by an on-board computer according to special algorithms and corresponding programs.

The main destination of air ducts and pipes in the "navel-string" is determined after the end of towing, i.e. when meeting the iceberg.

Along with this, the process of pumping in and out can be used at the initial stage, and namely when rolling the cloth into a doubled roll.

Rolling a cloth into a roll can occur either in a specially equipped port (as it has been described earlier) or in an open sea as it would be described below.

The initial position of the cloth in this case is considered the one which is shown in Fig.1, i.e. when the cloth is on the water surface with the layer having fastening belts turned up.

In this case the cloth is connected to the vessel by a "navel-string" through which the volume of air necessary to maintain the cloth in the spread state on the water surface is pumped into the air cushions.

As it can be seen from Fig.1, the longest rows of cushions in the web pass the diameter or are situated close to it, i.e. these are the rows which go to the "outlet" 5.

Correspondingly, the shortest rows are those which are situated in just the opposite edges of the cloth on both sides of the "outlet" 5.

One of these two cloth edges is shown in Fig.6.

The shortest row 15 of air cushions being the most extreme one can be seen, then the second row 16 and the third row 17 from the cloth end.

Two extreme rows 15 and 16 are folded under an angle to each other along the line of the channel dividing them and are mounted in the third row 17 as a gable roof and are fixed in this position.

Then the air is pumped out of the air cushions rows mentioned as well as out of several neighboring rows resulting in lowering this part of the cloth into the water.

This operation 9 but in the transverse cross-section) is shown in Fig.7 where air cushion rows 18 with the air are seen on the water surface.

Air cushion rows 19 with the air pumped out are submerged into water in the form of a vertically hanging chain.

Air cushion rows 19 serve as the links in the chain, channels 20 are their hinges, and the chain itself terminates with a triangular loop of the last three rows which have been folded as a gable roof when on surface.

After this water is pumped into the air cushion row 15 making one of the triangle sides.

The quantity of the air pumped in should be strictly measured and it should be sufficient only for pushing up the side 15 and be a little higher than the weight of the two other sides 16 and 17, so that not to cause floating up of all the triangle.

With such pumping in the side 15 would be able only to turn in the direction of the surface round its hinge.

In this case, it is natural that together with side 15 the corresponding turning is to be made by other triangle sides 16 and 17.

During its turning the side 15 will primarily occupy the horizontal position, and then after passing it will move to an inclined one coming closer to vertically hanging chain.

When nearing the chain the potential of side 15 is to gradually decrease, but in the process of turning side 16 will be gradually nearing that position in space which has been previously occupied by side 15.

With such changes in the position of triangle sides in space air from side 15 should be gradually pumped out with simultaneous gradual and strictly measured air pumping into side 16.

Thus, smooth change in the triangle sides will occur, and rotation of the triangle itself will be carried out in a continuous regime.

Such point-pulsation system of pumping in and out into the triangle sides causes its rotation during which it winds up the chain simultaneously rising to the surface.

Fig.7, right gives the scheme of such a rotation showing the triangle in several positions in space.

After the part of the cloth with the air pumped out and vertically hanging in water will be rolled into a roll by the method described above, further rolling of this roll will continue in the way as shown in Fig.8.

In Fig.8, as well as in Fig.7, the cloth and the rolled roll are shown in a transverse cross-section.

Part of the cloth with the air cushion row 18 filled with air is shown on the water surface.

A part of the cloth with air cushions row 19 from which the air is pumped out goes into depth from it and sags in water.

This part of the cloth is connected with the roll wound from the depth up to the surface as it was explained when describing Fig.7.

Further winding of the roll goes according to a definite program "pumping in – out".

According to this program all air-cushions of the wound roll should contain such a quantity of air which would permit it to remain not very deep under the water surface without floating up to it.

But for the process of winding to be carried out a definite part of the roll should contain additional quantity of water.

It should be that part of the roll which occupies its lower left quarter in the transverse cross-section. To make it clearer a clock face is shown in Fig.9 where the quarter which the hand moves from 6 to 9 is shaded.

Additional quantity of air in the quarter of the roll should be strictly measured, i.e. it should be insufficient for the roll floating up to the surface, but sufficient for the roll to turn round.

As the left lower quarter will tend to occupy the position of the left upper quarter, turning of the roll will occur clockwise, i.e. the roll itself will be wound on the cloth part sagging in water with row 19 from where the air has been pumped out.

To continuously wind the roll it is necessary that the force vector tending to turn the roll appeared from the left lower part of the roll.

It is possible only in the case when the additional air quantity will remain constantly only within the limits of the left lower part even with the roll rotation.

This means that the system of "pumping in – out" should constantly part the air out of those rows of air cushions which leave the left

lower part with the roll rotation and, conversely, to pump air into those rows which are entering this quarter.

Along with this, air should be constantly pumped out from the cloth 18 remaining on the water surface and, correspondingly, new and new parts of cloth 19 serving for winding up the roll during rotation should go under water.

According to the method described above the roll is wound up to the middle of the cloth, i.e. up to the "outlet".

In the same way with the direction of the "outlet" but from another side of the cloth, the second roll should be wound.

When both rolls meet in the middle, i.e. at the "outlet", the process of the cloth transformation into the doubled roll can be considered as terminated.

After this the quantity of air necessary for floating up is pumped into the rolls of the doubled roll, so that they float up to the surface, but in this case the front end of the roll (that one where the "navel-string" is being fastened to) should be lifted a little above the water, and its rear end should be drowned a little.

In this position the doubled roll shown in Fig.5 is ready for towing.

Towing of the doubled roll is carried out up to its meeting the iceberg, after which the new stage begins.

The method proposed necessitates to carry out a very responsible operation – doubled roll laying along the underwater part of the iceberg.

When moving the iceberg several preparatory operations are carried out.

First of all, the iceberg line of symmetry is determined by the corresponding instruments from the technological vessel and a helicopter rising from its deck.

The line of crossing the outer contour of the iceberg with the symmetry plane, i.e. the vertical plane is called the symmetry line, and it conventionally divides the iceberg into two approximately equal parts and moves through the deepest point of the iceberg underwater part.

The line dividing the upper part of the iceberg from its underwater part is called the coast line of the iceberg.

The symmetry line crosses the coastal line in two absolutely opposite points.

For convenience, one of these points is called a "straight" point, and the other (at the opposite side) is called a "reverse" one.

The main purpose of the given stage is the pressing of the doubled roll against the symmetry line of the underwater part of the iceberg in such a way that one end of the doubled roll (Fig.16) connected to the

technological vessel by a "navel-string" goes into water opposite to the "reverse" point 21, and after girding all the underwater part of the iceberg the other end of the doubled roll appears on the surface opposite the "straight" point 22.

One of the most important things is that the doubled roll should be pressed against the iceberg bottom by its flat strip, i.e. in comparison to its position when towing, it should be turned with the bottom (i.e. the flat strip) up.

After determining the symmetry line of the iceberg and checking the coordinates of the "straight" and "reverse" points a winch, a guiding cable and a set of hoisting cables is loaded on the iceberg.

A winch and a set of hoisting cables are moved to the highest point of the iceberg upper part, and a guiding cable remains on the coastal line near to the "straight" point 22.

After this the operation of the doubled roll turning with the flat strip up begins.

From one of the rolls in the doubled roll air is being pumped out due to which it goes under water, while the sufficient quantity of air should be pumped into another roll in the quantity sufficient to hold the weight of the first rolled which moved under water remaining afloat at the same time.

Thus, the former doubled roll position when the rolls differ only as the right and the left ones, and a flat strip connects them horizontally is changed for such a position in which the rolls are distinguished as an "upper" and "lower" ones, and the flat strip connects them vertically.

After this air pumping in begins into the lower (underwater) roll.

Pumping in is carried out in several stages, the first of them consists of air pumping only into one row of air cushions situated along the outer surface of the roll on the line from which a flat strip moves up to the surface.

The second and further stages air is pumped in the rows of air cushions which surround the first already pumped row to the left and to the right, as well as inside the roll.

Such pumping carried out into the width and depth from the line of the flat strip adjoining the lower roll will lead to the fact that the pushing up force will raise the roll to the surface.

As the vector of the pushing force goes from the line adjoining the flat strip to the lower roll, then this line will be the first to appear on the surface preliminary raising the flat strip out of water.

With further pumping the lower roll will be raised to the surface even more, and the flat strip will change its inclined position more and more approaching to a horizontal one.

When the lower roll will completely appear on the water surface, and it will be possible to distinguish the rolls as the "right" and the "left" ones, the flat strip will again connect both rolls along the horizontal but only from above.

In case during towing the flat strip was considered as the bottom, in the new position it can be called the "roof".

The new position of the doubled roll is shown in Fig.10.

In this new position the doubled roll is towed by the technological vessel for a short distance from the iceberg, then the vessel turns and going by reverse motion and pushing the doubled roll in front, it takes the rear end of the roll to the "straight" point at the coastal line (Fig.11).

After this guiding cable 23 which is situated at the "straight" point is fastened by one end to the rear end of doubled roll 24 and by the other to winch 25 which is at the highest point of the iceberg upper part.

After this air is pumped out from all the doubled roll except its front part (where it is connected to the "navel-string").

The doubled roll begins to submerge into water with its corresponding end (it is shown in Fig.12).

As the rear end of the doubled roll is submerged into water, then the guiding cable fastened to it is also going under water.

After the submerging of the doubled roll into water is finished, the technological vessel towing the submerged doubled roll begins its movement round the iceberg.

Having gone round the iceberg for 180° , the vessel stops opposite "reverse" point 21 (start of the maneuver is shown in Fig.13, and its termination is shown in Fig.14).

Guiding cable 23 fastened to the rear or , according to the situation, the lower end of the doubled roll has also made all the route round the iceberg and is now sagging under it.

As the guiding cable is fastened by one end to the lower end of the doubled roll and by other end it appears in the upper part of the iceberg in the "straight" point, this means that the guiding cable is sagging in the symmetry plane, i.e. its vertical projection upwards will go along the symmetry line of the iceberg bottom.

As for doubled roll 24, its correct position in Fig.14 is considered to be one when the doubled roll is turned with its flat strip to the "reverse" point.

It was this position that was sought for when making operation on turning the doubled roll with its flat strip upwards after towing.

It could happen that the doubled roll wasn't turned upwards during this maneuver due to some reasons.

In his case the doubled roll would face the "reverse" point not with the flat strip but with rolls which is technologically unacceptable.

To correct this position the upper, i.e. above water part of the doubled roll is turned as a screw for half a turn along its axis so that the flat strip should face the "reverse" point and then the upper (above water) part of the doubled roll is again fastened to the stern of the vessel.

As for the underwater part of the doubled roll, it cannot be surely stated which side of the doubled roll is facing the "reverse" point because during towing round the iceberg and, especially, in the case of being turned round its axis the underwater part of the doubled roll can become concave, intervened, etc.

For the doubled roll to be leveled off along its length and to have its flat strip facing the "reverse" point in its upper and underwater part, it should attain a suspended condition.

This means that all the underwater part of the doubled roll is uniformly filled in with air along its length up to the moment when the doubled roll is ready to float but is not doing so.

In this position all the underwater part of the doubled roll is straightened, bent or twisted parts are leveled off, rolls are rounded, etc.

After the time when the inertia oscillations of the doubled roll are attenuated, it would be leveled off along all its length as the position of the underwater part of the doubled roll is determined by its stationary part rigidly secured to the stern.

Leveled off doubled roll with the flat strip facing the "reverse" point is ready for girding the underwater part of the iceberg along the symmetry line, i.e. from "reverse" point 21 to "straight" point 22.

This process begins with hoisting the guiding cable by the winch, this cable in its turn raising the doubled roll by its lower end.

During this process of hoisting the doubled roll will change its vertical position for an inclined one up to the moment when it will touch the underwater part of the iceberg by its flat strip (Fig. 15).

The further hoisting of the guiding cable occurring, as it has been marked, in the symmetry plane, will cause the laying of the doubled roll along the underwater part of the iceberg which is naturally going along the symmetry line.

This process must be accompanied by air pumping into that part of the flat strip of the cloth which is touching the iceberg bottom at the moment.

Thus, hoisting of the roll and air pumping into its flat strip occur simultaneously coinciding in the moment of touching the underwater part of the iceberg.

In the given joint action the guiding cable during hoisting provides for laying the doubled roll along the symmetry line, and air pumping into the flat strip will press it against the bottom of the iceberg, thus fixing the doubled roll on the symmetry line.

This situation is shown in Fig.18 where both the doubled roll and the iceberg bottom are shown in a transverse cross-section.

After finishing this process when the doubled roll will be pressed by its flat strip to the symmetry line of the underwater part of the iceberg from "reverse" point to a "straight" one, the guiding cable will take out the end of the doubled roll on the water surface at the iceberg side opposite to the vessel anchorage at one side of the iceberg, i.e. opposite the "straight" point 22.

This position serving as the final stage of laying of the doubled roll along the underwater part of the iceberg is shown in Fig.16.

As all the other steps of the given stage (Fig.12, 13, 14, 15) are given in the position of the "side view", Fig.16 has also used this aspect.

The situation shown in Fig.16 is also given in positions with "top view" (Fig.17) and "transverse cross-section" along the iceberg bottom (Fig.18) as these aspects are used for describing the next stage.

Rolling out the roll along the underwater part of the iceberg is a very important stage for realization of the method proposed.

As it has already been noted, in the doubled roll pressed against the iceberg the air is pumped only into its flat strip.

Fig.18 shows (in transverse cross-section) flat strip 14 pressed against the bottom of iceberg 26 and rolls 13 of the doubled roll.

On both sides of the flat strip two sections 27 of the doubled roll are situated occupying an intermediate position between the flat strip and rolls.

When pumping air into these intermediate parts they float up and immediately thrust into the iceberg bottom.

As the result of such air pumping the flat strip widens for the width of these two intermediate strips, the rolls will move from one another for this distance and will decrease in diameter for the corresponding value, and new intermediate parts 27 will appear between the flat strip and the rolls.

When continuing air pumping in turn in the air cushion rows of these intermediate strips the flat strip will constantly widen along the

iceberg bottom, and the rolls will move at longer distances from one another (Fig.19).

Flat strip widening along the iceberg bottom will be widening in the same way along the side surfaces of the iceberg, and on the water surface it will look like two parts of the cloth edges between the rolls on both sides of the iceberg.

This situation is shown in Fig.20 (top view).

Outer end of one of these parts (opposite "reverse" point 21) is connected with navel-string 28, and the outer end of the second one (opposite "straight" point 22) is connected to guiding cable 23.

General understanding of the process of girding the underwater part of iceberg by a doubled roll gives comparison of situations in Fig.18 and 19 and, correspondingly, in Fig.17 and 20.

Widening of the flat strip of the doubled roll along the iceberg bottom and rolling of the rolls is to be continued up to the moment when the flat strip covers all the iceberg bottom and the rolls move to their edges.

After this if air pumping is continued, it leads to rolling the rolls along the side surfaces of the underwater part of the iceberg, i.e. upwards, in the direction of the water surface.

After finishing this process, the doubled roll disappears being transformed into the "bag-bubble" which embraces the underwater part of the iceberg by its bigger part and takes some quantity of sea water while the other (upper) part of the bag floats on water surrounding the upper part of the iceberg in the form of a ring with definite width.

This situation is shown in Fig.22 (side view) and in Fig. 21 (top view).

Ring 29 surrounding the upper part of the iceberg on the water surface represents that upper part of the "bag-bubble" destined for closing the upper part of the iceberg.

Outer edge of this ring is connected with the "navel-string" (opposite the "reverse" point) and with the guiding cable (opposite the "straight" point).

Removal of sea water taken by the "bag-bubble" together with the iceberg is carried out by pumping it out through the "navel-string" along the pipes which have open outlets 11 (Fig.4) inside the "bag-bubble".

As it has been noted before when the cloth was rolled into the doubled roll a special condition was to be observed, and namely the fact that the inner layer of the rolls in the doubled roll should be the cloth layer with bracing belts.

Correspondingly, the outer layer in the rolls was another cloth layer, and namely that where pipe outlets 11 are positioned.

These outlets 11 can be visible on the doubled roll only when the roll is turned with the bottom up after towing the cloth to the iceberg (Fig.10).

And due to the fact that the doubled roll presses against the iceberg and the rolls along the underwater part of the iceberg by this very layer, it appears later functioning as an inner layer of the "bag-bubble".

After pumping the water out the "bag-bubble" appears to be pressed against all the underwater part of the iceberg, and the floating part of the "bag-bubble" destined for closing the upper part of the iceberg appears immediately near the coastal line.

This situation is shown in Fig.23 (side view).

After this a very responsible stage in the proposed method of closing the upper part of the iceberg begins.

Closing of the upper parts of the iceberg is to be carried out by the floating part of the "bag-bubble" which surrounds the upper part of the iceberg on the surface in the form of ring 29.

As it has been noted before, guiding cable 23 is fastened to the outer edge of this ring (opposite "straight" point 22).

As it is the guiding cable which begins lifting this ring from the water surface on the upper part of the iceberg, then for facilitating this process it is desirable to move the outer edge of the ring as close to the iceberg coastal line as possible.

After pumping out sea water from the "bag-bubble" ring 29 floating on the water surface approaches the iceberg coastal line by its inner circumference as close as possible (this is evident when comparing situations in Fig.22 and Fig.23).

To make the outer edge of the ring floating in the surface closer to the iceberg coastal line, it is necessary to pump out all the air from the air cushions except for the air cushions of its outer edge.

As the result of this ring 29 goes under water, and its outer edge remaining on the surface approaches the iceberg coastal line (fig.24).

After this the "navel-string" can be disconnected from the "bag-bubble" and delivered to the vessel, and the winch begins hoisting of the guiding cable 23.

As a result of this hoisting the part of the cloth outer edge where the guiding cable is secured is to be taken to the coastal line of the iceberg.

As the outer edge with its part hoisted by the guiding cable on the upper part of the iceberg is nothing else but the edge of cloth 8 (Fig.1), then the hoisting cable is secured to the nearest hoisting loop 9 appearing on the lifted part, and the hoisting cable, in its turn, lifts the next part of the cloth

edge with a new hoisting loop 9 to which new hoisting cable is fastened and so on.

The start of this process is shown in Fig.24 where not to make the drawing cumbersome only guiding cable 23 is shown secured to the outer edge of cloth 8 and only one hoisting cable 30 which is to be fastened to the nearest hoisting loop 9.

Hoisting cables 30 fastened to hoisting loops lifted to the coastal line one after another lift first only the edge of cloth 8 or, in other words, upper edge of the "bag-bubble" wholly on the iceberg coastal line.

After having lifted all the upper edge of the "bag-bubble" on the coastal line, its graduate pulling on all the upper part of the iceberg up to its top begins.

On the top of the upper part of the iceberg the "bag-bubble" is closed by means of attachments and devices providing for reliability and waterproofness of this unit during its long way of drift.

Upper part of the "bag-bubble" closing the upper part of the iceberg is to be braved by bracing belts 10 (Fig.25).

System of bracing belts on the cloth (Fig.3) represents two centers of concentric circumferences, each consisting of rings decreasing in diameter.

Each center of the circumferences occupies its half of the cloth.

Each ring making the center of circumference has its bracing belt 10 fed through loops 31 (Fig.26).

Loops 31 are positioned at equal intervals on the circumference of the bracing belt and are fastened (glued or welded) to the surface of the layer.

Tightening of each ring is carried out by means of special attachments for tightening 32 (Fig.26) which are also positioned on the circumference of the belt at definite intervals.

Necessity in several attachments for bracing on one ring is caused by the fact that the system of bracing belts is used at the stage described as well as in the further stages for shaping this gigantic hot water bottle with fresh water as an elongated vessel convenient for towing.

At these stages there can appear different parts of the bracing belt circumference above the water (an obligatory condition for possible bracing of attachment 32) and, hence, there should exist several attachments on the whole circumference.

After transforming the cloth into the "bag-bubble" with the iceberg inside it (Fig.25) the system of bracing belts made of flat concentric circumferences as they appeared on the cloth is transformed into rings bracing the iceberg as parallels on the globe but positioned vertically and not horizontally.

In case each of the bracing belts is tightened with bracing attachments positioned on the upper part of the iceberg, then this part of the iceberg

and the "bag-bubble" covering it appear to be tightly pressed one against the other, thus preventing the "bag-bubble" from destructive actions of waves.

After tightening bracing belts, the personnel carrying out the operations described above transfers all the equipment from the iceberg to the technological vessel.

Then the personnel leaves the iceberg packed into the "bag-bubble", and the iceberg continues its natural drift.

When the iceberg enters warm waters, ice in the "bag-bubble" begins to melt, and after some time a gigantic "hot water bottle" full of fresh water will drift on the sea surface.

When the time for towing comes, before towing all the bracing belts are tightened for one and the same diameter. This should give an elongated shape to a shapeless "hot water bottle", such as a "torpedo" or a "log", thus considerably decreasing water resistance when towing. (fig.27).

Making conclusion for all the above said, it should be underlined the technical solution described presents a practically real project, has a number of advantages in comparison with all the other solutions (projects) on the given subject patented earlier.

The main advantage of the solution proposed lies in the fact that it can be really achieved as it is much simpler than all that has been proposed earlier on the subject.

It is much more profitable as it doesn't include complex and cumbersome protection from impacts of the waves, and there is no necessity in developing any system of thermal insulation.

Absence of necessity in towing the iceberg packed into the "bag-bubble" at the stage when it can move from the poles by its natural drift also makes the realization of the proposed solution cheaper.

The same circumstance makes it even more safe as there is no necessity to risk the crew of the towing boat under heavy and sometimes storm conditions of polar seas, especially if all this takes place during the polar night.

The "bag-bubble" can enclose icebergs of any shape, that's why the solution proposed can be applied to icebergs in both poles, and not only for Antarctica as in all the previously proposed solutions.

The main idea of the solution proposed consists in packing the iceberg into a waterproof "bag-bubble" and completely excludes any losses of fresh water.

With complete melting of the ice there is an ability of towing the "bag-bubble" in an elongated shape of a "torpedo" or a "log", thus considerably decreasing water resistance (additional economic advantage).

It cannot be excluded that such a "torpedo" or a "log" can be towed through straits and even canals, thus considerable widening the geography of fresh water supplies.

The solution proposed doesn't exclude the ability, in case it appeared to be profitable, for mooring water tankers to the "bag-bubble" under drift or in the process of towing for pumping out water from it with further delivery to ports which are passed by this "bag-bubble" during drift or towing.